composition

is defined, as in the work standard creation system 2800 and standard manhour setting system 2801. In other words, the set of work data linked to each other by the above hierarchical relationship defined by the work standard creation system 2800 is succeeded by the manhour setting file 3601 of the standard manhour setting system 2801 while holding the hierarchical relationship.

The hierarchical relationship and contents of work data succeeded by the manhour setting file 3601 are edited or worked by the standard manhour setting system 2801. Work data as the result must also be succeeded by the work assignment system 2802 from the standard manhour setting system 2801. For this purpose, the work assignment system 2802 has a user interface capable of designating one or more or all of the four layers as data load targets from the standard manhour setting system 2801.

As such a user interface, for example, to load data from the manhour setting file 3601 in units of genres, the name of the genre is input to a field 7401, as in the example shown in Fig. 74. In a field 7402, a set of all work data at the "genre" level present in the field 6301 of the standard manhour setting system 2801 is displayed.

In the example shown in Fig. 74, bubble-jet printer (BJ), facsimile apparatus (FAX), laser beam printer (LBP), and the like are displayed as genres. When one genre is

selected in the field 7401, and an "OK" button 7408 is clicked, a set of all work data belonging to the genre is downloaded from the manhour setting file 3601.

If the user wants download in units of "representative models", the name of a genre to which the representative model belongs is input to the field 7401. Then, the names of all representative models belonging to the selected genre are displayed in a field 7404. When, of these displayed names, the name of a desired "representative model" is double-clicked, the name is copied to a field 7403, and then, the "OK" button 7408 is clicked.

If the user wants download at the "target model" level, the name of the target model is input to a field 7405, or a field 7406 is selected, and then, the "OK" button 7408 is clicked.

The work assignment system 2802 has a user interface capable of setting to download a plurality of "components" at the "component" level at once. In a field 7407 shown in Fig. 74, the names of all components belonging to a "target model" of a "representative model" in a "genre" are displayed, so a plurality of "components" can be selected while designating the download order thereof. To designate the download order, sequential numbers are input to an order column 7409 of the "components" selected by clicking of the mouse.

The user interface shown in Fig. 74 and, more

particularly, arbitrary setting at the component level has the following advantage.

For example, assume that work data of a model named "X" is stored in the manhour setting file 3601, and components "A", "B", "C", "D", "E",... belong to the model "X", as shown in Fig. 75. When the user interface shown in Fig. 74 is used,

model "X1" (including the components "A", "B", and "C"),

model "X2" (including the components "A", "B", and "D"),

model "X3" (including the components "B", "C", and "A"),...

can be downloaded from the model "X", as shown in Fig. 75. When these new models "X1", "X2", and "X3" are downloaded, they are registered in the work assignment system 2802 as new directories. The reason for this is as follows. Since the work composing operation is close to the site of assembly, it is preferable to allow the user to determine work composition with components more appropriate to the site of assembly and also, even for the same model, define work composition whose components are easily changed.

To create a plurality of different "model" directories from one "model" directory, the work assignment system 2802 adds "?n" (n is a number) to the directory name of the original "model".

Fig. 76 shows a user interface window for opening an

existing file in the composition table file 6400. In the work assignment system 2802, to open an existing file, files are selected in units of "target models". The "target model" includes the "target model" defined in the field 7405 in Fig. 74 and the "target models" newly automatically defined in Fig. 75.

The user clicks on one of a plurality of "target models" displayed in the field 7601 using the mouse or inputs the name of a desired "target model" to a field 7602. The "revision number " of the selected "target model" is displayed in a field 7604. Whether the composition data input window or composition data editing window for the selected "target model" is to be displayed is selected by check buttons 7605.

Referring to Fig. 77, work data loaded to the memory of the work assignment system 2802 by the above-described download or file open operation are displayed in units of "target models".

More specifically, the work data are displayed as a list in a field 7706. The name of the target model is displayed in a field 7701, the file name is displayed in a field 7702, and the revision number is displayed in a field 7703. A "total work count" N_{TW} for the "target model" is displayed in a field 7707, and the total manhour is displayed in a field 7708.

The number or name of a work selected in the field 7706

with the mouse is displayed in a field 7705. The total manhour in composition is displayed in a field 7709.

An input for defining conditions for composition is done in a window 7710. Bibliographic data of the composition result are displayed in a window 7720.

Data_related to the above-described equation (1) are input to the input window 7710. More specifically, the user inputs the number of units (the number of products) U to be produced by one crew as a set of a plurality of operators per day to a field 7710a, time (i.e., operation time of each station) H (unit: RU) obtained by subtracting an exclusive time such as a break from one-day working time of one crew (a set of a plurality of operators) to a field 7710b, and the target composition efficiency (i.e., expected composition efficiency) E to a field 7710c. As the total manhour in the composition, which is represented by equation (1), the total manhour (field 7709) not input by the user but calculated by the system is used, as described above.

When "calculate" button 7710d is clicked, the number of stations N_{ST} is calculated in accordance with equation (1), and the pitch time T_P is calculated in accordance with equation (2) on the basis of the conditions input to the window 7710.

The number of stations N_{ST} is automatically calculated in accordance with $N_{ST} = (U \times WF)/(H \times E)$ (equation (2)) and displayed in a field 7720a when the value is rounded down

or in a field 7720b when the value is rounded up, together with the composition efficiency. That is, when the number of stations N_{ST} is rounded down, the composition efficiency becomes higher than the target composition efficiency (field 7710c), and when the number of stations N_{ST} is rounded up, the composition efficiency becomes lower than the target composition efficiency.

The pitch time T_P is displayed in a field 7720d.

The user can edit the composition in units of works while looking at the window shown in Fig. 77. The editing commands are "divide", "integrate", "insert before", "insert after", "delete", "change work order", "in composition", and "outside composition". These editing menus are done from the editing menu provided by the window system or by selecting a desired work with the mouse and clicking the right button of the mouse.

To "divide" a work means that one unit work is divided into two unit works. The manhour value of each divided unit work is "0". The number of each divided element work has a subnumber. The name of each divided element work has an indent.

To "integrate" works means that two element works are integrated to one unit work. The manhour of the integrated unit work corresponds to the sum of manhours of the respective element works as integration targets.

With the "insert before" menu for a work, a work

designated by the dialog shown in Fig. 78 is inserted before a selected work. More specifically, the name of work to be inserted is written in a field 7801, and a temporary manhour value is written to a field 7802.

The "insert after" menu for a work is almost the same as the above "insert before" menu.

With the "change work order" menu, the positions of two works are exchanged.

With the "in composition" or "outside composition", it is determined whether a work is to be subjected to composition or excluded from the composition targets.

The operation of composing all works of the "target model" is started by clicking on an "execute composition" start button 7730.

Fig. 79 is a flow chart for explaining the control procedure of composition. In step S790, counters i, j, and k for work are initialized to "1", and a register T for storing the accumulation time of manhours for each station is initialized to "0".

In step S791, data of a work wj (manhour tj) indicated by the counter j is extracted. In step S792, the manhour tj is accumulated to the time register T. In step S793, the counter j is incremented by one. In step S794, it is determined whether the manhour value accumulated in the time register T exceeds the pitch time T_p. If NO in step S794, the flow returns to step S791 to repeat the above-described

operation.

That the accumulated manhour value T of manhours tk to tj exceeds the pitch time T_p means that works wk to wj should belong to a station Sti, so the works wk to wj are assigned to the station Sti. In step S796, the counter i is incremented to prepare for setting the next station. In step S797, the counter k is returned to "j", and the time register T is initialized to "0".

In step S798, it is determined whether the counter value j representing the work number exceeds the total number of works N_{TW}. If YES in step S798, the processing is ended.

The control procedure shown in Fig. 79 determines assignment of works to stations with priority on the manhour. That is, assignment is determined that the accumulated manhour value T preferentially should not exceed the pitch time T_p. The number of assigned stations may eventually be larger than the number of stations N_{ST} set as a target, and if so, the composition efficiency changes accordingly.

For work assignment, a determination method with priority on the number of stations (Fig. 95) or an assignment determination method based on the accumulated manhour value (Fig. 96) can be proposed as a modification.

The assignment method shown in the flow chart of Fig. 95 gives priority on that the total number of stations to be assigned works should not exceed the upper limit value N_{ST}. For this purpose, variables, a parallel number ni and

total accumulated parallel sum number n0, are newly introduced, unlike the control shown in Fig. 79. The parallel number ni is the number of stations that can be parallel-operated in the stations i.

In step S950, the counters i, j, and k for work are initialized to "1", the register T for storing the accumulated time of manhours for each station is initialized to "0", and the total accumulated parallel sum number n0 is initialized to "0". In step S951, data of the work wj (manhour tj) indicated by the counter j is extracted. In step S952, the manhour tj is accumulated to the time register T.

That is, the accumulated manhour value of the manhours tk to tj is stored in the time register T. In step S953, the counter j is incremented by one. In step S954, it is determined whether the manhour value for the station i exceeds the pitch time T_p. Since the station i is allowed to parallel-operate ni stations in advance, and the manhour that can be assigned to the station i is $T_p \times ni$, more works can be assigned to the station i when

$$T < T_p \times ni \quad \ldots(4)$$

When

$$T \geqq T_p \times ni \quad \ldots(5)$$

no more works can be assigned to the station i. In step S954, such determination is done. In step S955,

$$i + n0 < N_{ST} \quad \ldots(6)$$

is determined to confirm that the total number of stations

assigned works does not exceed the upper limit value N_{ST}. More specifically, when equation (5) holds for a certain station i (the assigned manhour T exceeds the pitch manhour ($T_p \times ni$) considering parallel operation), the station Sti is newly set in step S956 unless the total number of stations (i + n0) set so far exceeds the upper limit value N_{ST}.

The purpose of step S955 is to prevent the number of assigned station from exceeding N_{ST} by assigning works beyond the pitch manhour T_p to the final station.

If YES in step S955, the counter i is incremented in step S957 to prepare for setting the next station, and the register n0 is updated in accordance with

$$n0 = n0 + (ni - 1) \quad \ldots(7)$$

where ni in (ni - 1) is the parallel number defined in advance for incremented i, i.e., the station i to be taken into consideration next. Hence, n0 in equation (7) is the accumulated value of parallel numbers set for the first to (i-1)th stations. In step S958, the counter k is set to "j", and the time register T is initialized to "0".

In step S959, it is determined whether the counter value j representing the work number exceeds the total number of works N_{TW}. If YES in step S959, the processing is ended.

As described above, in the control procedure shown in Fig. 95, to prevent the number d of assigned stations St from exceeding the number of stations N_{ST} set as a target, all works remaining at the time of end of assignment to the station

(i - 1) are assigned to the final station (i.e., station i). With this method, the number of assigned stations is prevented from exceeding N_{ST} by assigning works beyond the pitch manhour T_P to the final station.

However, in the method shown in Fig. 95, the load (manhour) may be concentrated to the final station. To prevent this, the assignment method shown in the flow chart of Fig. 96 has as its object to keep the number of stations N_{ST} set as a target and distribute the load (manhour) without concentrating the load to the final station such that the variation in manhour between the stations is easily evened. To do this, unlike the control shown in Fig. 95, let Ti be the manhour to be assigned to the station i, and T0 be the accumulated manhour assigned to all stations assigned works. Additionally, a new variable, station manhour T_A is introduced.

The station manhour average value T_A is defined by

$$T_A = WF/N_{ST} \quad \ldots(8)$$

When equations (1) and (2) are taken in consideration.

$$T_A = E \times T_P \quad \ldots(9)$$

In the control procedures shown in Figs. 79 and 95, the pitch time T_P defined by equations (1) and (2) is used as a reference for determination whether the station Sti is to be set. However, the control procedure shown in Fig. 96, the station manhour average value T_A defined by equation (8) is used as data for determination whether the station Sti

is to be set.

In step S960 of Fig. 96, the counters i, j, and k for work are initialized to "1", the register T for storing the accumulated time of manhours for the station i is initialized to "0", the total accumulated manhour T0 is initialized to "0", and the total accumulated parallel sum number n0 is initialized to "0". In step S961, data of the work wj (manhour tj) indicated by the counter j is extracted.

In step S962, the manhour tj is accumulated to the time register T. That is, the accumulated manhour value of the manhours tk to tj for the station i is stored in the time register T. In step S963, the manhour tj is accumulated to the time register T0 to update the total accumulated manhour T0. In step S964, the counter j is incremented by one. In step S964, it is determined whether

$$T0 > T_A \times (i + n0) \quad \ldots(10)$$

As described above, (i + n0) is the total number of stations assigned works so far in determining whether the ith station is to be set. For this reason, when equation (10) holds, all works corresponding to the accumulated manhour Ti can be assigned to the station Sti in step S965.

In the method shown in Fig. 95, assignment is determined on the basis of the pitch time T_P that is uniform to all stations. However, in the method shown in Fig. 96, the accumulated value based on the manhour average value T_A

is used as a reference. Hence, works are prevented from being excessively assigned to a specific station.

Fig. 80 shows an example in which the composition created by the control procedure shown in Fig. 79 is displayed. As characteristic features of the work assignment system 2802, composition can be easily corrected, as described in association with Fig. 69, and also, correction can be done while confirming the correction process in real time. Referring to Fig. 80, the work assignment states of five out of the total of N_{ST} stations are displayed.

The number of stations for display is limited to five due to a limitation on the screen size of the display unit. The total manhour value of each station is stored and displayed in a field 8004.

The total manhour of each station is displayed in a bar graph (8006). The composition efficiency is displayed in a field 8007.

Reference numeral 8008 denotes a display window of works outside the composition; and 8009, a display example of a menu displayed by clicking the right button of the mouse. The work outside the composition and the works listed for the station can be exchanged.

The editing commands "divide", "integrate", "insert before", "insert after", "delete", "change work order", "in composition", and "outside composition" are allowed for

works displayed in the composition target definition window shown in Fig. 77. As in this window, editing commands "divide", "integrate", "insert before", "insert after", "delete", "change work order", "in composition", and "outside composition" are also prepared for the works listed for the five stations displayed on the window shown in Fig. 80. In the compositor data correction window, the "change work order" menu is displayed as a "move" menu.

The function of "dividing" a work in the composition result will be described first.

This function is necessary when the user looks at the graph in Fig. 80, finds that the manhour of a specific station is particularly larger than that of the remaining stations, and wants to divide the specific work. In this case, one of the divided subworks is left to the station, and the other subwork is moved to another station. "Divide" and "move" in this example will be described with reference to Figs. 81 to 83.

Assume that a plan as shown in Fig. 81 is obtained by a composing operation. As is apparent from the example shown in Fig. 81, the total manhour of station 1 is larger than that of station 2 by 38 RU. The cause for this is the work "A4" assigned to station 1, as is known from the work table.

The user selects the work "A4" with the mouse, displays the menu by clicking the right button of the mouse, and selects the "divide" menu (or double-clicks). The work "A4" is

divided into works "A4-1" and "A4-2" each having a 1/2 manhour, as shown in Fig. 82. The user selects the "move" menu to move the work "A4-2" from station 1 to station 2. The result of movement is reflected to the graph, as shown in Fig. 83.

For the remaining functions, e.g., "integrate", "insert", and "delete" of a work as well, a desired work is selected with the mouse, and the menu is selected (for "integrate", the menu can also be double-clicked), thereby reflecting the editing result to the graph.

The editing function in the work assignment system 2802 includes not only editing in units of work but also editing in units of stations. The functions are "delete", "insert", "add", and "parallel integrate" of a station.

With "delete" of a station, a station which has become empty as a result of "move" of works is deleted. As a detailed user's operation, an empty station is selected in the window shown in Fig. 80. The right button of the mouse is clicked to display the "delete" menu of the station, and the menu is selected, thereby deleting the station. A station can also be added to add a work.

With "insert station ", an empty station is inserted between two stations. As a detailed user's operation, an arbitrary work in the station located on the front side is selected with the mouse. Next, the right button of the mouse is clicked to display the "insert station" menu, and the menu is selected. With this operation, an empty station is

inserted.

With "add station", a station is added next to the station as an addition target. As a detailed user's operation, an arbitrary work in the station as an addition target is selected with the mouse. Next, the right button of the mouse is clicked to display the "add station" menu, and the menu is selected. With this operation, an empty station is added. The newly created station is additionally displayed after the station as the addition target. Since the added station has no work, a work is moved from another station.

With "parallel-operate stations", to allow work by a plurality of operators, a work in a station is divided into stations equal in number to the plurality of operators. As a detailed user's operation, a desired station is selected with the mouse, the right button of the mouse is clicked to display the "parallel integrate" menu, and the menu is selected. Then, a dialog shown in Fig. 84 is displayed. The number of stations to be divided is written in a field 8402.

Fig. 85 shows an example of station division before parallel operation. In this example, the number of works assigned to the station St2 displayed as "operator 2" is large, and the time is also long. With the above parallel operation, station 2 is divided into stations St2-1 and St2-2, as shown in Fig. 97.

For the illustrative convenience, St1 expressed as

"operator 1" in Fig. 85 corresponds to St1 expressed as "operator 1" in Fig. 97. However, St3 expressed as "operator 3" in Fig. 85 corresponds to St3 expressed as "operator 4" in Fig. 97. In addition, St4 expressed as "operator 4" in Fig. 85 corresponds to St4 expressed as "operator 5" in Fig. 97, and St5 expressed as "operator 5" in Fig. 85 corresponds to St5 expressed as "operator 6" in Fig. 97.

Addition of a station (or addition of a work) at the time of composition is effective when a station (or work) for check (inspection) is to be added. Whether the inspection process is necessary can hardly be determined by the work standard creation system 2800 for defining the work or the standard manhour setting system 2801 for defining the manhour. Such determination is necessary and possible when the work assignment system 2802 is operated. When a previous or subsequent station as an addition target is designated with the mouse, and the "add" station menu is selected, a newly created empty station is displayed after the addition target station.

<Modification to Composition>

The form of composition is not limited to the above examples.

For example, there may be a single work requiring a large manhour. Even when such a work is present, composition can be theoretically executed in accordance with equations (1) and (2). However, the time for the single work having

a large manhour exceeds the pitch time T_p. For example, one station is assigned to the single work, like station 2 shown by 8601 in Fig. 86.

The display shown on the upper side (8601) of Fig. 86 is not preferable because the window is inefficiently occupied. In the work assignment system 2802, letting n be a value obtained by dividing the total manhour in the station assigned such a single work having a large manhour by a number (to be referred to as a unit manhour hereinafter) obtained by multiplying the pitch time T_p by a predetermined value (a constant can be used), and rounding up the quotient, n operators are assigned to the station. The graph display of the manhour of such a station has a width n times the normal bar width. The width of the station 2 bar in Fig. 86 is doubled (8602 in Fig. 86). With this display, the user can understand at a glance that the station has a single work with a large manhour, and its manhour represented by a multiple of the above "unit manhour".

Only a specific user can perform the composing operation. The user interface window shown in Fig. 87 is an input window for checking the operator has a right for composition. The operator code is input to a person name code column 8701, the name of the operator is input to a column 8702, the position is input to a column 8703, the password is input to a column 8704, and the authority is input to a column 8705. The input data are collated with a personnel

database, and only when the data match, an access right is given.

Fig. 88 shows the data upload from the work assignment system 2802 to the work standard creation system 2800 when the work standard creation system 2800, standard manhour setting system 2801, and work assignment system 2802 have standalone structures.

As described above, the work standard creation system 2800 of this embodiment can attach voice or image data to a work standard. In the above embodiment, the work standard creation system 2800, standard manhour setting system 2801, and work assignment system 2802 build a client/server database system, as shown in Fig. 1. For this reason, the download or upload by batch operation of work standard data is unnecessary between the work standard creation system 2800, standard manhour setting system 2801, and work assignment system 2802.

However, when work standard creation system 2800, standard manhour setting system 2801, and work assignment system 2802 have standalone structures, as shown in Fig. 88, the data download or upload between the subsystems is necessary. In this case, it is inefficient to download or upload image data or voice data created by the work standard creation system 2800.

In the modification shown in Fig. 88, download or upload is limited to download or upload of minimum necessary

data. Merging between image data or voice data and work standard data composed by the work assignment system 2802 is executed by the work standard creation system 2800. This shortens the time required for the download or upload.

In addition, the work standard creation system 2800 can be connected to each station in the workshop through a LAN (communication network), so work standard data, including image data or voice data, can be downloaded to the workstation of each station through the LAN.

<Other Modifications>

M-1: The above-described embodiment is constructed under the client/server environment, as shown in Fig. 1. However, the present invention can also be applied to a standalone environment in a single computer system. In this case, the work standard creation system 2800, standard manhour setting system 2801, and work assignment system 2802 operate in the computer system.

M-2: In the above-described embodiment, various files are created in each system, and the formats of these files can be set in various ways. For example, these files need not always be so-called permanent files always stored in an external auxiliary storage device such as a disk and can be so-called view files which are present only on the main memory. This is because many files are temporarily created for the purpose of display (view).

[Other Embodiment]

The object of the present invention can also be achieved by supplying a storage medium (or recording medium) in which software program codes for realizing the functions of the above-described embodiment are recorded to an apparatus which operates as the above-described subsystem or the server/client, and causing the computer (or a CPU or an MPU) of the system or apparatus to read out and execute the program codes stored in the storage medium. In this case, the program codes read out from the storage medium realize the functions of the above-described embodiment by themselves, and the storage medium storing the program codes constitutes the present invention. The functions of the above-described embodiment are realized not only when the readout program codes are executed by the computer but also when the OS (Operating System) running on the computer performs part or all of actual processing on the basis of the instructions of the program codes.

The functions of the above-described embodiment are also realized when the program codes read out from the storage medium are written in the memory of a function expansion board inserted into the computer or a function expansion unit connected to the computer, and the CPU of the function expansion board or function expansion unit performs part or all of actual processing on the basis of the instructions of the program codes.

As has been described above, according to the assembly

information management system of the above-described embodiment, management can be more efficiently executed using work standard data suitable for computer processing.

In addition, according to the work standard creation system of the above-described embodiment, work standard data suitable for computer processing can be created.

Furthermore, according to the automatic manhour setting system of the above-described embodiment, the manhour can be quickly set for a work standard by computer processing.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.